# OPERATING MANUAL
# MODEL 10454T
# 20 WATT TWT AMPLIFIER

INSTRUMENT SHOP

MCL/INC
DESIGNERS AND MANUFACTURERS OF RF COMPONENTS AND SYSTEMS
TEN NORTH BEACH • LA GRANGE ILLINOIS 60525 • 312-354-4350

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TITLE:

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## 1.0 GENERAL

The purpose of this document is to outline the operating procedures for the MCL 20 Watt TWT Amplifier series.

THIS DOCUMENT IS NOT INTENDED AS A REPAIR MANUAL DUE TO THE EXTREMELY HAZARDOUS VOLTAGES INVOLVED.

Schematic Diagram 32D1362 or 32D1363 is used as a reference for this manual.

## 2.0 PRECAUTIONS

2.1 Observe AC input power requirements as outlined in Section 3.0.

2.2 Note the maximum load VSWR indicated on the front panel of the TWT Amplifier. The load VSWR is different for various tube types used and therefore is not included in this manual. Never allow the H.V. to be on if the RF input or output c onnections are unterminated.

2.3 To prolong tube life, do not allow the amplifier to remain in Standby for periods greater than 1/2 hour. It is best to keep the unit in transmit or shut off completely.

2.4 CAUTION: Lethal voltages are present during operation. Use only insulated tools in making adjustments with the high voltage on.

Dangerous voltages are also present during Standby conditions. Observe extreme caution in making any internal adjustment.

## 3.0 ELECTRICAL SPECIFICATIONS

3.1 AC input 115V/230V ±10%, 60 Hz, 6A max.

3.2 Input and output impedance 50 ohm. VSWR dependent upon the tube type used.

3.3 Helix, Collector and Fil P.S. are regulated.

3.4 Frequency RF power input and output is dependent upon model number and tube type used.

## 4.0 THEORY OF OPERATION

4.1 AC Power

The AC input of 115V or 230V, as determined by the back panel selector switch S105, is applied to J108. Fuses F101 and F102 located on the rear panel, protect the unit from AC overload. The AC control function is provided by PC board 1005-011-305, connected to J106. When the Main On switch S101 is depressed, blower B101 and Heater Regulator Assy. 1005-011-301 are activated. AC is applied to a time-delay circuit which in approximately 3 minutes will place the unit in a standby condition. This allows ample time to heat the cathode of the TWT. After standby operation is achieved, the HV On switch S104 may be activated. To revert to a standby condition, depress the Standby switch S102. Depressing the Main On switch will remove AC power from the unit.

4.2 HV-DC Regulator

The output of the T102 is rectified by CR101, filtered by CT02, and is regulated by PC Assembly 1005-003-301 and the pass tube V101.

4.3 Heater Regulator

The PC card 1005-008-301 is a heater regulator and provides a stable DC voltage to the heater of the TWT tube.
NOTE: THIS SUPPLY IS AT A NEGATIVE VOLTAGE OF 1400 TO 4000 VOLTS DEPENDENT UPON THE TWT TUBE USED. DO NOT ADJUST THE HEATER VOLTAGE WHILE THE UNIT IS IN A HV "ON" CONDITION.

4.4 Cathode "Turn-On"

Upon initial application of the High Voltage, the anode is clamped to the cathode through K501. When the cathode potential reaches 70 to 90% of its operating value, K501 will open and return the anode to its normal potential, allowing beam current to flow. This sequencing is provided to prevent the TWT from de-focusing and drawing excessive current.
NOTE: HV IS PRESENT ON THIS BOARD DURING OPERATION

4.5 Resistor Assembly

The resistor assembly 1005-010 provides an error signal to the voltage regulator sense input to provide the HV regulation and also controls the turn-on level of relay K501.
NOTE: HV IS PRESENT ON THE BOARD DURING OPERATION

4.6 Over-Current Protection

Relay board 1005-011-301 provides Helix over-current protection. If the Helix current rises above the set value, relay K403 will open the interlock circuit and the unit will revert to a standby condition.

4.7 Temperature Interlocks

A thermal interlock is provided on the TWT tube heat sink and will open the interlock line if an air restriction or failure occurs. The tube overheats due to excessive current or the ambient inlet air temperature reaches a level that will not properly cool the tube. When the condition is rectified and the tube cools to a temperature below the limit of the sensing switch, HV operation can again be achieved.

4.8 Chassis Interlock

When the top cover is removed, S108 will open, causing a Standby condition and preventing the HV from being applied. This switch

4.8 Chassis Interlock (con't)

can be defeated for servicing by pulling up on the actuating pin until a click is heard and the pin remains up. S104 may now be depressed and the HV will be activated. USE EXTREME CAUTION IN MAKING INTERNAL MEASUREMENTS OR ADJUSTMENTS.

4.9 Metering

A panel meter M101 is provided to measure Helix and beam (cathode) current. The meter reads directly for Helix current and readings must be multiplied by 10 for beam current measurement. S107 on the panel selects the function of the meter. The normal values of current will differ with various tube types and is noted in the test data.

5.0 GAIN CONTROL

5.1 The front panel gain control (R106) will provide approximately 6 db of control over the TWT. NO STATEMENT -

6.0 RF TESTING

Refer to the block diagram in paragraph 6.0 for the test connections. This will vary to some extent dependent upon the frequency range and available equipment. Apply an input signal through the input directional coupler to the system. The power level is monitored by the power meter connected to the forward port of the directional coupler. Output power is monitored through the directional coupler on the output line of the TWTA. Measure output power and gain at the rated power of the TWT (20W) vs. frequency, and record on the data sheets in paragraph 9.0. Record also the Helix current under drive. Special tests will be made as required per individual unit.

7.0 RF TESTING BLOCK DIAGRAM

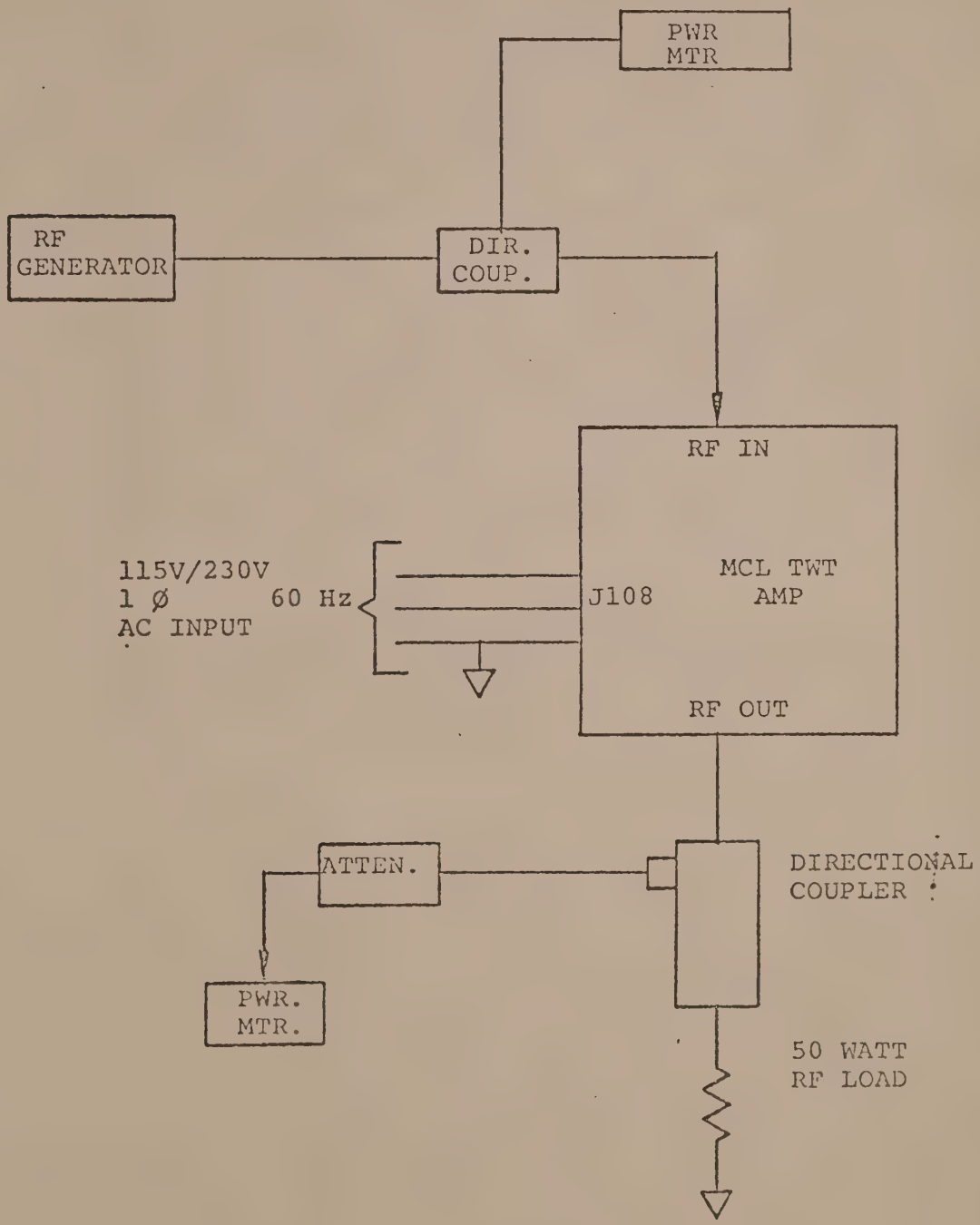
See Sheet 7 of 9.

8.0 SERVICE

During the warranty period, the unit should be returned to MCL for service. Unauthorized repairs will void the warranty. After this period expires, maintainance, calibration, and repair may be done at the customers facility or the unit may be returned to MCL for such service and will be billed to the customer. It is recommended that TWT tube replacement be effected at MCL facilities.

TITLE:

7.0 RF TESTING BLOCK DIAGRAM



## 9.0 WARRANTY

Under recommended use and service, all MCL products are warranted against defects in material and workmanship for nine (9) months from the date of original shipment. Material returned after 90 days of the original shipping date will be repaired on a pro-rata basis. MCL's obligation is limited to repairing or replacing at our plant , products which prove to be defective during the warranty period. Tubes. transistors, and other solid state devices are covered by the respective manufacturer's warranty which applies from the date of shipment of the unit from MCL.

MCL is not liable for consequential damage resulting from the use of MCL equipment.

There will be no charge for repair of units under warranty except non-authorized shipping charges. In the event that responsibility for repair lies with the customer, customer will be charged for the cost of re-testing, repair and shipment. Estimates of charges will be supplied before work begins.

CLAIM FOR DAMAGE IN SHIPMENT:

Your unit should be inspected and tested as soon as it is received. Claims for damage should be filed with carrier.

SHIPPING:

Upon receipt of shipping instructions, forward the unit to the destination indicated. For non-warranty service, the unit must be shipped prepaid.

## 9.1 VSWR PROTECTION OPTION

All standard MCL travelling wave tube amplifiers are protected against high VSWR terminations when equiped with the high VSWR protection option. This option consists of a three port circulator and associated low reflection termination. The circulator is connected between the TWT output connector and the amplifier output. High VSWR reflections from a poor amplifier termination are then absorbed by the protection circuit termination. Although the protection circuit components are rated for 100% reflections at the maximum amplifier power level, long periods of operation without a termination or a short are not recommended.

## 10.0 TEST DATA

| | | |
|---|---|---|
| CATHODE VOLTAGE | 3171 | V |
| ANODE VOLTAGE | 300 | V |
| HEATER VOLTAGE | 6.5 | V |
| WARM-UP TIME | 125 | SEC |
| QUIESCENT HELIX CURRENT | 3 | MA |
| QUIESCENT CATHODE CURRENT | 81 | MA |
| DRIVEN HELIX CURRENT | 7 | MA |
| AC LINE CURRENT | 6.0 | A |

| FREQUENCY MHz | RF INPUT MILLIWATTS | RF OUTPUT WATTS | GAIN DB |
|---|---|---|---|
| 4.0 | .16 | 20 | 50.7 |
| 4.5 | .073 | 20 | 54.3 |
| 5.0 | .051 | 20 | 55.9 |
| 5.5 | .031 | 20 | 58.1 |
| 6.0 | .028 | 20 | 58.5 |
| 6.5 | .040 | 20 | 57.0 |
| 7.0 | .051 | 20 | 55.9 |
| 7.5 | .12 | 20 | 52.2 |
| 8.0 | .14 | 20 | 51.5 |
| | | 20 | |

Tested September 30, 1975

TELEDYNE MEC

3165 PORTER DRIVE • STANFORD INDUSTRIAL PARK • PALO ALTO, CALIF

# FINAL TEST DATA

TUBE TYPE M5789-M

SERIAL No. 102

~~S.O.~~/RTA 12334

| OPERATING CONDITIONS | | | POWER SUPPLY REQUIREMENTS | | |
|---|---|---|---|---|---|
| ELEMENTS | VOLTAGE | CURRENT | VOLTAGE MIN. | VOLTAGE MAX. | CURRENT MAX. |
| Helix | Ground | 3 mA | Ground | | 15 mA |
| Collector | +1500 v | 78 mA | 1500 | Ground | 90 mA |
| Cathode | -3233 v | 81 mA | -3000 | -3400 V | 105 mA |
| Anode | +300 v | 0 mA | 0 | 300 V | 1.0 mA |
| Heater | 6.3 v | .85 A | 6.3 ± 2% Reg. | | 1.6 A |

Note 1: Cathode and Anode voltages are measured with respect to Ground.

Note 2: Collector voltage is measured with respect to Cathode.

Helix current will vary with operating conditions, it must never exceed 15.0 mA.

Conduction Cooling: Base plate temp. 100° C maximum.

| POWER SUPPLY CONNECTIONS | |
|---|---|
| Flying Leads | |
| Heater-Cathode | Yellow |
| Heater | Brown |
| Collector | Red |
| Anode | Blue |
| Helix-Ground | Black |
| Thermostat | Gray (Note #1) |

Note #1: Thermostat contacts normally closed.

Setup Instructions 1900

Intergrate with Power Supply N/A, Serial No. N/A.

| RF PERFORMANCE | | | |
|---|---|---|---|
| Frequency | Sat. Power Output | Gain @ 43 dBm | Small Signal Gain |
| Min. | 43 | 45 | 45 |
| Max. | | | |
| GHz | dBm | dB | dB |
| 4.0 | 44.0 | 50.5 | 51.7 |
| 4.5 | 43.6 | 52.9 | 55.4 |
| 5.0 | 44.6 | 56.7 | 58.0 |
| 5.5 | 45.0 | 57.8 | 58.8 |
| 6.0 | 45.1 | 57.0 | 59.6 |
| 6.5 | 45.5 | 58.3 | 58.9 |
| 7.0 | 45.4 | 56.8 | 57.1 |
| 7.5 | 45.3 | 54.7 | 55.2 |
| 8.0 | 45.1 | 51.1 | 51.5 |

Broadband Noise Figure < 35dB 35 dB Max.

VSWR, Input < 3.0:1 3.0:1 Max.

VSWR, Output < 3.0:1 3.0:1 Max.

DATE 4/2/75

SUPERVISOR [signature] QC [signature]

T101
1005-009

S101

LY

X

LY (1) DC101

115V
230V

F101 6A
F102 3A
F103 5A
F104 3A

S105

B101
TWT Blower
BLUE
WHITE
RED

C105
1 mf
370 VAC

T102
1005-006

CR101

R110 100Ω
R111 150Ω
R105 22 MΩ
C102 2 mf
R101 39K
C101 .0047
R102 100Ω
V101 4X150A
C103 0.5 μF
R103 470Ω
R104 1KΩ

T103
1005-007

(INCLUDED WITHIN V102)
S106
NO
NC
THERMO SWITCH

| REVISIONS | | | | |
|---|---|---|---|---|
| SYM. | DESCRIPTION | | DATE | APPROVAL |
| A | ORIGINAL | JSK | 2-24-73 | RJB |
| B | ADD R110 & R111, CHG. WIRING OF C103 | | 6/5/73 | |
| C | DS102 WAS DS103, DS104 WAS DS102 ADDED C105 | NB | 6/27/73 | |
| D | ADDED TP501 | JSK | 7/18/73 | 7/19/73 |
| E | 3A WAS 2.5A | GH | 2-20-74 | |
| F | REVISED | GH | 5-15-74 | |
| G | CORRECTED PER 3538 ECO | GH | 7-24-74 | |
| H | JUMPER Q203 COLLECTOR AROUND J201 BUSS + DELETED GRID FROM J203 | DS | 4/11/75 | |

CR301

F301

J301 BRN (HTR. -)

A

Z

VH247

Q303 2N5142

Q304 2N5780

R301 120Ω

C302 10uf

C301 1000uf

R302 200Ω

R303 470Ω

R304 .33Ω

CR303 1N5343

4

J302 YEL.

(HTR +)

HEATER ASS'Y 1005-308-301

C501 47pf

R512 R511 R510 R509 R508 R507 R506 R505 R504 R503 R502 R501

R517 R518 R519 R520 R521 R522 R523

A

V

C502 .0047uf

TP501

CR505 IN4005

CR504 IN4005

R525 560KΩ

C506 .22uf

C504 .22 uf.

C505 .47uf

R526 1MΩ

C508 .05 uf.

Q501 2N3439

CR503 IN-4005

CR502 IN4005

R524 100K

CR501 IN5260

C507 .01 uf

M

C503 .47 uf

P

K

S

GAIN R106

K501

N

V10Z

HEV/X

C666

TB101

S102 S103 NO NO INTLK. 2.P INTLK. T.C.

H.V. S104

H.V. DS104 DS102

J101 18 U 8 14 M H 6 E 4 10 16

CR401

105V

C401 15μ

R407 680

K401 K402 K403

R401 68kΩ

R402 22M

R403 22M

R404 22M

R405 22M

V401

C402 2μ

R406 1K

P401

+C404 .1μ 150V

R410 47Ω

CR403

R408 1.5kΩ R409 10kΩ HELIX OVERLOAD ADJ.

C403 10μ

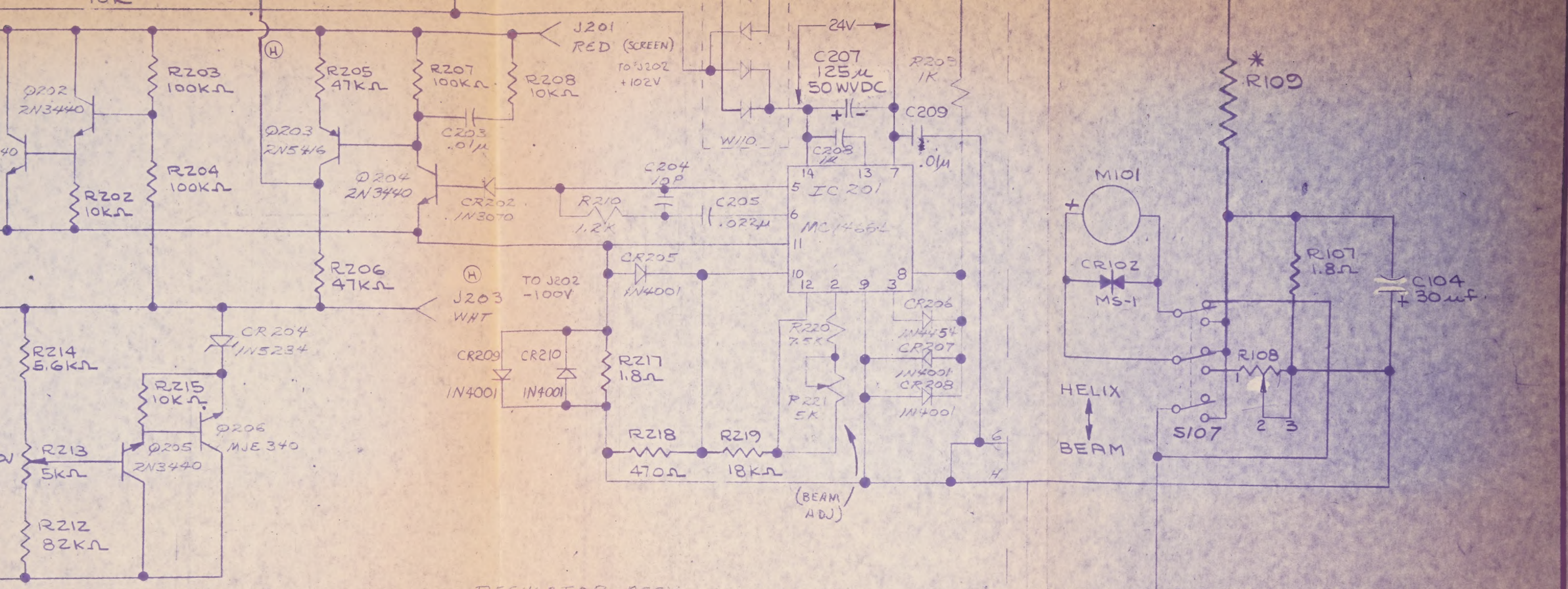
(GND) BLK J401

J202 BLK (COM)

R223 47Ω CR201 R224 47Ω R20 5K

VE-68

RELAY ASSY. 1005-011-301




REGULATOR ASSY.
C1005-3

* FACTORY ADJUST

| ITEM | PART NO. | QTY. | DESCRIPTION | MAT'L. | MAT'L. SPEC. |
|---|---|---|---|---|---|

LIST OF MATERIAL

| | | | |
|---|---|---|---|
| 10457T | ~ | ~ | ~ |
| 10453T | ~ | ~ | ~ |
| 10451T | ~ | ~ | ~ |
| 10450T | ~ | ~ | ~ |
| NEXT ASS'Y | USED ON | NEXT ASSY | FINAL ASSY |
| APPLICATION | | QTY. REQ'D. | |

DO NOT SCALE:

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES FRACTIONAL ±
DECIMAL ±
ANGULAR ±

MATERIAL: ~
SPEC:
FINISH: ~
SPEC.

| | | |
|---|---|---|
| DRAWN | JSIC | 2-26-73 |
| CHECKER | | |
| MECH. ENGR. | | |
| ELEC. ENGR. | RJB | 4-4-73 |
| PROJ. ENGR. | | |
| CHIEF ENGR. | | |

SCHEMATIC
20WATT TWT
FOR USE WITH
TELEDYNE TUBES

SCALE: WEIGHT ACT. CALC.

MCL MICROWAVE CAVITY LABORATORIES
MICROWAVE CAVITY LABORATORIES
LAGRANGE, ILLINOIS

32D1363

SHEET OF

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